

21ST CENTURY U.S. NAVY MINE WARFARE

ENSURING GLOBAL ACCESS AND COMMERCE



21ST-CENTURY U.S. NAVY MINE WARFARE

Sea mines and the need to counter them have been constants for the U.S. Navy since the earliest days of the Republic. Mines and mine countermeasures figured prominently in the Civil War, Spanish-American War, both World Wars, Korea, numerous Cold War crises, and in Operations Desert Storm and Iraqi Freedom. Today, traditional navies as well as maritime terrorists can and do use mines and Underwater Improvised Explosive Devices (UWIEDs) to challenge military and commercial use of the seas. These “weapons that wait” are the quintessential global asymmetric threat, pitting our adversaries’ strengths against what they perceive as our naval and maritime weaknesses.

In February 1991 the Navy lost command of the sea—the North Arabian Gulf—to more than a thousand mines that had been sown by Iraqi forces. Mines severely damaged two Navy warships, and commanders aborted an amphibious assault for fear of even more casualties. Spurred on by this experience, the Navy has taken consistent, aggressive and focused action to ensure that it is prepared for all future mine “events.”

The Navy has crafted an overarching vision for mine warfare, generally, to support national strategies and operational plans, while focusing on mine countermeasures in order to decrease significantly the time it takes to conduct mine countermeasures operations and to ensure that the residual risk is low.

Our focus, however, is not solely on “away games”—overseas crises, contingencies, and conflicts. We are increasingly concerned about the possibility of

Mine Countermeasures Vision

- Improve detection capability
- Decrease sensor false alarm rate
- Reduce or eliminate post-mission analysis detect, classify, identify, decide time
- Automatic target recognition
- Improve neutralization time
- Improve network communications
- Achieve in-stride detect-to-engage capability

<i>21st-Century U.S. Navy Mine Warfare</i>	1
<i>What’s Past is Prologue</i>	3
<i>The Threat is Real</i>	7
<i>Defeating Weapons that Wait</i>	11
<i>Mines and Mining</i>	25
<i>Organizing for Mine Warfare</i>	26
<i>Mine Warfare Vision</i>	27
<i>Mine Warfare Reading List</i>	29

terrorists using mines or underwater improvised explosive devices in domestic U.S. ports and waterways. Traditional naval forces and terrorists can use these weapons for military effects *and* psychological terror—with the potential for significant harm to the global economy—what the Secretary of Defense has described as “hybrid wars.” Thus, mine countermeasures is key to national military and maritime security strategies and worldwide commerce.

To defeat the mine threat, the Navy has established the Mine Warfare Center of Excellence at the Naval Mine and Anti-submarine Warfare Command. The Service is co-locating the Mine Warfare Forces to enhance training and readiness, and has forward deployed mine countermeasures staffs, ships, helicopters, and explosive ordnance disposal detachments to guarantee quick responses to mine crises world wide. An officer Mine Warfare career path and the Mineman rating for enlisted mine warfare experts ensure critical skills in the operating forces. And, the Navy is developing and deploying advanced mine-hunting and minesweeping systems and the intelligence and oceanographic capabilities that will enable our mine warfare superiority.

Our vision is focused and clear. Our people are skilled and experienced. Our research and development, acquisition and in-service programs are forward-leaning and promise enhanced effectiveness. We will ensure success in this most challenging naval warfare area.



Major General Thomas A. Benes, USMC
Director, Expeditionary Warfare N85
Office of the Chief of Naval Operations



E. Anne Sandel
Program Executive Officer
Littoral and Mine Warfare

WHAT'S PAST IS PROLOGUE

Mine warfare is the strategic, operational and tactical use of sea mines and the countermeasures to defeat them. Although the concept of a sea mine can be traced to “Greek Fire” used to defend Constantinople in the year 673, in the American experience the first use of mines or “torpedoes” came in an unsuccessful 1776 attack against HMS *Eagle* in the Hudson River. The first successful U.S. Navy mining occurred during the War of 1812, when mines denied British access to the Port of New York.

During the Civil War, sea mines became the South's strategic sea-denial weapon of choice. This catalyzed the Union Navy to develop mine countermeasures systems and tactics—including some that still have 21st-Century applications. Almost all, however, were *ad hoc* innovations created at the shipboard level by individual commanders, as no infrastructure within the Union Navy focused on mines and mine countermeasures. In contrast, the Confederate Navy had a mine infrastructure that was heavily engaged in research and development, and even included a “sapper corps” and a spy network to increase the effectiveness of the South's mines. Still, Admiral David G. Farragut's command at Mobile Bay to “... damn the torpedoes, full speed ahead...” was made easy by two months of extensive mine countermeasures that included reconnaissance, mine hunting, and technical exploitation of captured weapons. He understood the threat and took his force through an area that was mine free. By war's end, however, 48 Union ships had been severely damaged or sunk by Confederate mines; ironically, the South's mines also sank 11 Confederate ships.

“Torpedoes [mines] are not so agreeable when used by both sides; therefore, I have reluctantly brought myself to it. I have always deemed it unworthy of a chivalrous nation, but it does not do to give your enemy such a decided superiority over you.”

*Rear Admiral David G. Farragut, USN
March 1864*

MINE WARFARE PIONEER



Connecticut farm boys David Bushnell and his brother worked in secrecy to design and build something they called a “sub-marine.” Dubbed the *American Turtle* because it resembled two turtle shells joined together, the submersible was armed with a “torpedo” limpet mine to be screwed into the hull of its intended victim. Piloted by a soldier named Ezra Lee, the *Turtle's* 6 September 1776 attack against Lord Howe's flagship was frustrated by bad luck and the “passive protection” of the *Eagle's* iron fittings. Retiring at dawn, Lee released the mine to float toward the British warships, and, when it fired, the large plume of water panicked the ships' crews.

In January 1778, Bushnell used floating kegs of gunpowder fitted with contact firing mechanisms to attack the entire British fleet anchored in the Delaware River above Philadelphia. Four British sailors died trying to retrieve the kegs—an early example of explosive ordnance disposal against an unknown threat—but the fleet was unscathed.

Bushnell was more effective the previous summer of 1777, however. He rigged a double line of “torpedoes” to attack the British warship *Cerberus*. The British prize crew of a captured American schooner saw the mines and attempted to haul them on board, causing them to fire, killing most of the crew and sinking the schooner—certainly the origin of the phrase, “any ship can be a minesweeper, once.” *Cerberus* was unharmed.

At war's end, General George Washington called Bushnell “a man of great mechanical powers” and “fertile in imagination.”

The U.S. Navy confronted mines at Manila Bay and Santiago during the Spanish-American War. And, the Russo-Japanese War of 1904-1905 saw the first significant use of mines in a “blue-water” naval campaign. The Russians employed mines in defensive postures, while the Japanese focused on offensive mining in deep water. In all, mines claimed three battleships, five cruisers, four destroyers, two torpedo boats, and one minelayer (sunk by a mine it had just planted). Russia sank more ships by mines than by any other means of attack.

Many thousands of mines served tactical sea-denial and strategic ends in both World Wars. Russia, Germany, Turkey, Great Britain and the United States relied on sea mines throughout the Great War. The mining campaigns culminated in the “North Sea Mine Barrage” of June-October 1918, when British and U.S. ships laid more than 73,000 mines, which sank as many as 13 U-Boats and kept many more in home ports until Armistice Day.

Mines of all types—including advanced magnetic, acoustic and pressure influence mines and electrical-potential/antenna-fired weapons—were used successfully in all World War II theaters. Even the U.S. homeland was at risk, as U-boats laid 327 mines from Halifax, Nova Scotia, to the Mississippi Delta, closing several ports for a total of 40 days and sinking or damaging 11 ships. Toward the end of the war in the Pacific, the U.S. Operation Starvation showed the strategic value of mines. From March to August 1945, U.S. Army aircraft and Navy surface warships and submarines laid more than 25,000 mines in Japanese shipping routes and territorial waters. The results were unequivocal: mines sank some 760 Japanese ships, damaged many more, and strangled all maritime commerce into and around the home islands.

Throughout this history, mine countermeasures attempted to keep pace with the development of new sea mines and the adaption of counter-countermeasures on existing mines. For example, the Navy developed degaussing of major ships, paravanes, a variety of mechanical/magnetic/acoustic sweeps, and dedicated mine countermeasures vessels—even blimps—during the wars.

Mine hunting and clearance operations are dangerous and time consuming, even after hostilities have ceased. By October 1945, U.S. Navy mine countermeasures forces in all theaters had swept more than 10,200 contact mines, but rendered-safe less than 500 influence mines. It took hundreds of mine countermeasures vessels—mostly Japanese—working for several years to clear U.S. sea mines in “essential waters” only, and in 1971 the Navy estimated that more than 2,000 sensitive influence mines remained in Pacific waters. Today, mine countermeasures vessels participating in the NATO Blue Harrier Exercises in the Kattegat and North Sea find and destroy World War I and II-era mines.

The Korean conflict underscored a failure of U.S. mine countermeasures. At the end of World War II, the U.S. Navy had more than 500 mine-clearance ships, but by the summer 1950 that number had atrophied to just 15. While the surprise amphibious landing at Inchon on the west coast of Korea went well, more than 3,000 mines utterly frustrated the October 1950 assault on Wonsan on the east coast. A 250-ship United Nations amphibious task force could not carry out the plan, causing task force commander Rear Admiral Allen E. “Hoke” Smith to lament, “We have lost control of the seas to a nation without a navy, using pre-World War I weapons, laid by vessels that were utilized at the time

of the birth of Christ.” The initial clearance operations saw three mine countermeasures vessels sunk by mines, with more than 100 dead and wounded. By the end of hostilities in July 1953, mine countermeasures forces, which accounted for just two percent of all UN naval forces, had suffered 20 percent of naval casualties.

Although the Chief of Naval Operations Admiral Forrest Sherman in early 1950 had put in place a mine warfare “get-well” program, the Korean debacle further stimulated a wide-ranging renaissance in U.S. Navy mine warfare research and development, experimentation, and acquisition. The Navy supported numerous surface and, for the first time, helicopter mine countermeasures platforms, systems, and technologies during the 1950s and 1960s. U.S. shipyards delivered nearly 250 surface mine countermeasures vessels for U.S. and allied navies. Advanced multiple-influence mines also emerged from the Navy’s research and development community, focused on defeating a resurgent Soviet Navy intent on challenging the United States and its allies worldwide.

Vietnam was significant for both mining and mine countermeasures. U.S. aircraft dropped some 11,000 “Destructor” mines converted from general-purpose bombs in coastal waters, rivers, and even along jungle trails. In May 1972 the Navy mined Haiphong harbor with Destructor and magnetic-acoustic influence mines in a strategic campaign to bring the North Vietnamese back to the Paris Peace Talks. Thousands



more mines were seeded and re-seeded, stopping virtually all water-borne trade with North Vietnam and trapping several Soviet Bloc ships in North Vietnamese ports. As part of the Paris Peace Accords, the United States agreed to clear the mines in a seven-month effort—Task Force 74 Operation End Sweep—that saw the first use of dedicated airborne mine countermeasures helicopters to sweep mined areas.

During the 1980s Tanker War in the Arabian Gulf, the guided-missile frigate USS *Samuel B. Roberts* almost sank, with potentially great loss of life, after striking an Iranian contact mine (that was based on a 1908 Russian design) on 14 April 1987—only the most heroic efforts by the crew kept the frigate afloat. Estimated to cost about \$1,500, the mine caused some \$96 million in damage to the warship.

“...when you can’t go where you want to, when you want to, you haven’t got command of the sea. And command of the sea is a rock-bottom foundation for all our war plans. We’ve been plenty submarine-conscious and air-conscious. Now, we’re going to start getting mine-conscious—beginning last week!”

*Admiral Forrest P. Sherman, USN
Chief of Naval Operations
October 1950*

Desert Storm saw another mine countermeasures failure. As the U.S.-led Desert Shield coalition built up combat strength in the fall and winter 1990-1991, the Iraqis were laying more than 1,300 sea mines in the Northern Arabian Gulf—a deadly “mix” of World War II-era weapons and modern multiple-influence mines, including a design never seen before in the West. As the Air War raged overhead, the USS *Tripoli* (LPH-10), the mine countermeasures commander’s flagship, and USS *Princeton* (CG-59), an Aegis guided-missile cruiser assigned as the mine countermeasures force anti-air warfare guard ship, were seriously damaged by sea mines. Almost immediately, U.S. commanders shelved plans for an amphibious assault intended to retake Kuwait City, leaving some 30,000 Marines at sea in their ships. Intensive “Desert Sweep” operations began immediately after hostilities ceased, but it took several years of mine-clearing efforts by coalition forces using captured mine field plans to conclude that principal channels were safe for ship traffic. Today, the Navy maintains a robust mine countermeasures posture forward deployed to the Arabian Gulf to respond to mine-clearance needs.

The 1991 Gulf War was also the last time that the Navy deployed mines in combat. Four A-6 Intruder bombers planted a tactical minefield of Quickstrike bomb-conversion mines

at the mouth of the *Kwahr Az Zubayr* River, to deny Iraqi access to the northern Gulf, and one aircraft was lost to ground fire. The Navy also used the Quickstrike mines against bridges and airport runways, with good effect.

Contrasting the Navy’s experiences at Wonsan in 1950 and the 1991 Gulf War are the highly successful countermeasures efforts in support of Operation Iraqi Freedom in 2003. U.S. intelligence, surveillance, and reconnaissance assets were keyed to the likelihood that Baghdad would

“...I believe there are some fundamentals about mine warfare that we should not forget. Once mines are laid, they are quite difficult to get rid of. That is not likely to change. It is probably going to get worse, because mines are going to become more sophisticated.”

*Admiral Frank B. Kelso, II USN
Chief of Naval Operations
October 1991*



again try to seed the northern Gulf with mines. Although the Iraqi military managed to plant a few mines, Navy SEAL teams and special operations forces captured several disguised Iraqi “mine layers” (in reality barges and tugs) with more than 100 mines still on board. Australian, U.K. and U.S. Explosive Ordnance Disposal divers successfully cleared the mines that did get into the *Khor Abd Allah* waterway, just in time for much-needed humanitarian-response ships to begin offloading vital supplies at the strategic port of *Umm Qasr*.

For more than 230 years, sea mines have figured in America’s naval and maritime strategies, plans, programs, and operations. There is no indication that it will be any different, tomorrow. Indeed, as far as we can peer into the future, traditional navies and terrorists intent on doing the United States and its friends harm will embrace these ultimate asymmetric naval weapons.

THE THREAT IS REAL

A mine is a terrible thing that waits. More than a quarter-million sea mines of more than 300 types are in the inventories of more than 50 navies world wide, not counting U.S. weapons. More than 30 countries produce and more than 20 countries export mines. Even highly sophisticated weapons are available in the international arms trade. Worse, these figures are for sea mines, proper; they do not include underwater improvised explosive devices, which can be fashioned from fuel bladders, 50-gallon drums, and even discarded refrigerators.

Mines and underwater IEDs are easy to acquire or build and are cheap, but their low cost belies their potential for harm. Since the end of World War II, for example, mines have seriously damaged or sunk four times more U.S. Navy ships than all other means of attack combined:

- Mines—15 ships
- Missiles—1 ship
- Torpedoes/aircraft—2 ships
- Small-boat terrorist attack—1 ship

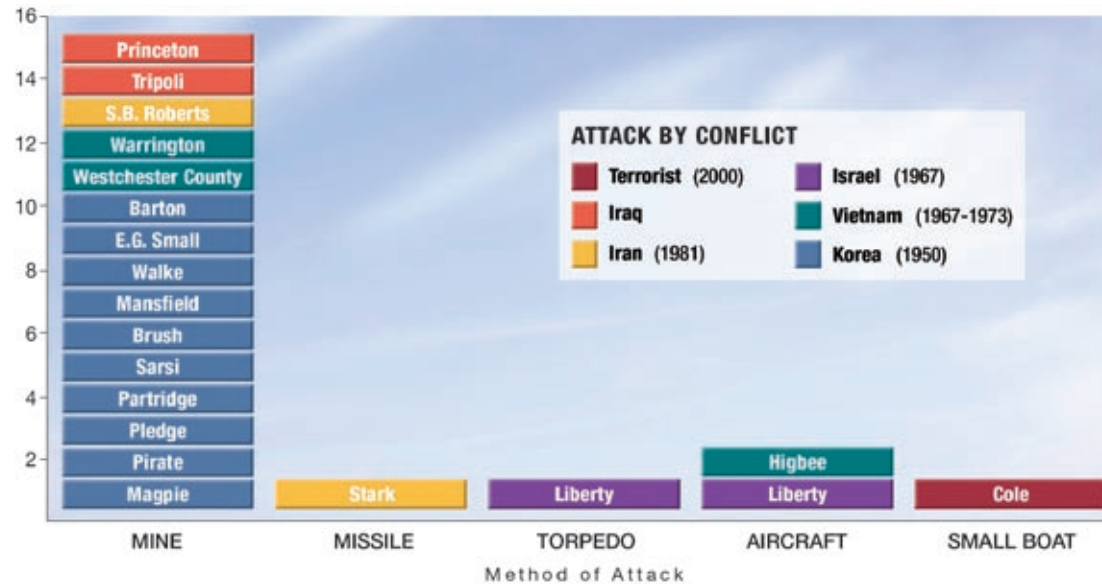


“Assured access is a linchpin of both our naval and national security strategies. Our first priority must be improving our near-term capabilities, but it is also important to keep an eye on our long-term vision of mine warfare.... Given the growing threat to our fleet and the current state of technology, we are fools if we don’t.”

*Admiral Robert J. Natter, USN
Commander, U.S. Atlantic Fleet
January 2003*

U.S. Navy Mine Casualties

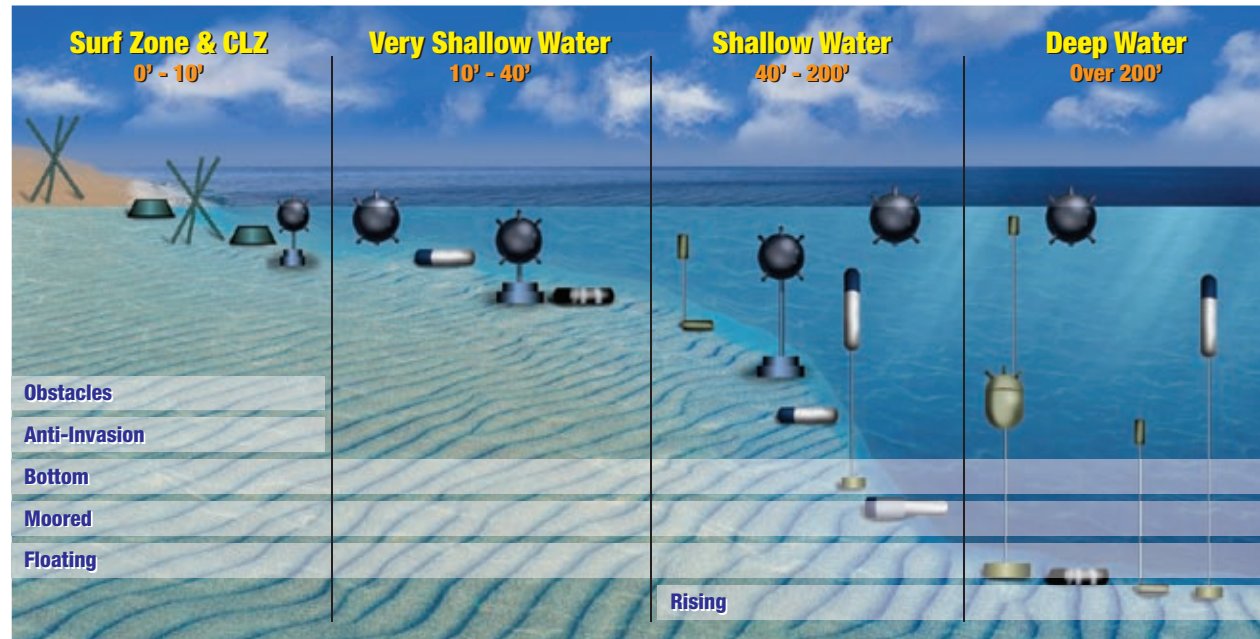
Since the end of World War II, mines have damaged or sunk four times more U.S. Navy ships than all other means of attack.



Although mines or underwater IEDs can be constructed in virtually any configuration, there are essentially four primary types: (1) bottom or “ground” mines; (2) buoyant moored mines; (3) drifting mines; and (4) limpet mines. They can be put in place by aircraft, surface ships, pleasure boats, submarines, and combat divers...even from pickup trucks crossing bridges over critical waterways. They are designed for operations from the surf zone (less than ten-foot water depth) to deep water (greater than 200 feet), and their payloads can range from a few pounds to several tons of high explosive.

Bottom mines resting on the sea floor—described as “proud”—are held in place by their own weight, but can also be buried under sediments to confound mine hunting. They range from 36-inch cone-shaped mines to mines that are 12 feet in length. Bottom mines that are intended to target surface ships are most effective in relatively shallow water, less than 200 feet. Deeper water limits the amount of damage that a bottom mine can inflict on a surface ship because of the mine’s distance from the target. Bottom mines remain effective against submarines in deep water.

Mine Warfare Regions



Moored Mines are assembled in buoyant cases and held in place by anchors. There are three types of moored mines: close-tethered mines near the sea floor, in-volume mines, and near-surface mines. Moored mines require a large internal air space to allow the mine case to become buoyant, which limits the amount of explosives that they can contain. As a result, the damage radius of a moored mine is generally less than that of a bottom mine. Some moored mines, however, are armed with torpedoes or rockets that greatly increase the weapons' "reach" against submerged and surface targets.

Floating mines are positively buoyant and float on or near the surface, but generally remain anchored in place. **Drifting mines** can be positively or neutrally buoyant and are carried by currents and tides. The dangerous oscillating mines



drift beneath the surface and are designed to rise and fall between two set depths. International law requires that automatic mines—mines that fire themselves—must become inert within an hour after they have been become free of their anchors. Clearly, drifting mines are not designed to become inert and are thus prohibited by treaty...but they continue to be used.

Finally, divers can attach **limpet mines** directly to the hull of an intended ship target, and they can be set to explode minutes or days or longer after being put in place. For example, in July 1985 two timed-delay limpet mines sank the Greenpeace *Rainbow Warrior* in the Auckland, New Zealand harbor.

Some mines are mobile, capable of being launched from submarines thousands of yards from intended minefields. Old mines can be refitted with modern, highly sophisticated components, and any mine can be equipped with counter-countermeasure features—e.g., “ship counts”—to frustrate sweeping, hunting, and neutralization. They can be fabricated from fiberglass and plastic, making them extremely difficult to detect, identify, or counter once in the water. And, they can be designed to fire in several ways: by contact, sensing the signatures or “influences” of a surface ship or submarine, and detonated on command.

Contact mines are either moored or surface/drifting mines that are designed to actuate when the mine cases or attachments come into contact with a target. These are the oldest type of mine still in use. Most contact mines use a chemical “horn” that becomes a battery to actuate the detonator when the chemical vial in the horn is broken.

Influence mines can be bottom or moored weapons and have sophisticated sensors and firing mechanisms that do not require the target to make contact with the mine before the mine explodes. They are fitted with just one or combinations of several magnetic, acoustic, seismic, underwater electrical potential, and pressure sensors. Modern sensors use microcomputers that can sense a target’s approach, determine whether the sensed signature is a ship or a sweep, and estimate the optimum time to detonate as the target passes by.

Command-detonated mines are moored or bottom weapons that are fired on order by the miner when the target ship enters the minefield. Command-detonated minefields are generally—but not always—limited to defensive operations in harbors or restricted waterways.

In the domestic context, mines and underwater improvised explosive devices are among many threats to U.S. maritime security interests. Terrorists can use or threaten to use mines and UWIEDs for a variety of political, economic, or military ends, often with psychological effects foremost in mind. While small devices might have no more than nuisance value, larger mines can be placed surreptitiously in channels and harbors to achieve spectacular effects—against, for example, ferries or cruise ships with several thousand people on board. And a coordinated mine or UWIED attack in multiple locations can have a debilitating, if not disastrous, economic impact.

Mines can directly attack the nation's waterborne trade. More than 90 percent of American exports and imports by volume transit U.S. ports, and the efficient and safe movement of foreign, coastal, and inland waters commerce is vital for America's economy. The economic consequences of just a few mines in commercial ports or strategic waterways like the St. Lawrence Seaway could be catastrophic, and the economic tremors could reverberate to trading partners overseas.

There could be serious military impacts, as well. While mines might not be "show-stoppers," they could certainly be "speed bumps" in critical waterways, slowing the movement of warships and military sealift in crisis and conflict.

Arrayed against this global threat, the Navy has put in place the people, platforms, systems, and technologies needed by Combatant Commanders to defeat mine warfare challenges. The operational requirements as well as the capacity and capabilities needed for the domestic counter-terrorism mine-countermeasures mission continue to be addressed. Whether at home or abroad, however, the Navy's mine countermeasures capabilities are focused on significantly decreasing the time it takes to conduct operations and to ensure that any residual risk remains small.

DEFEATING WEAPONS THAT WAIT

The Navy's "triad" of "dedicated" mine countermeasures forces comprises surface mine countermeasure ships, airborne mine countermeasures helicopters, and Explosive Ordnance Disposal (EOD) divers and their systems. Complemented by the Service's Marine Mammal Systems, Navy Special Warfare SEALs, and Marine Force Recon divers, each element of the dedicated mine countermeasures force brings a unique set of capabilities to the mine-defense problem. These dedicated forces are now being augmented by the expansion of the Service's "organic" mine countermeasures capabilities that will be embarked in Littoral Combat Ships and integrated into aircraft carrier and expeditionary strike groups.

MINES AND IEDs FOR TERROR

The "Patriotic Scuba Diver" mine crisis of January 1980 showed that a terrorist threat of mines—in this case the purported "mining" of the Sacramento River during the Soviet grain embargo announced by the President—could have chilling effects on maritime trade. An unknown person identifying himself as the "patriotic scuba diver" claimed by telephone to have placed a mine in the waterway; all shipping movements ceased. Once on scene, the Navy minesweeper required several days of intensive mine hunting to conclude the channel was safe. No mines were discovered, but the cost in merchant vessel "lay-days" alone was estimated in the hundreds of thousands of dollars.

The Red Sea/Gulf of Suez "Mines of August" crisis in the summer 1984 demonstrated how easily mines could be used as weapons of maritime terror. From 19 July to 13 September as many as 23 vessels reported damage from underwater explosions in the Red Sea and Gulf of Suez—attacks that generated a massive multinational mine-countermeasures response, including U.S. Navy airborne mine countermeasures helicopters. Only one new mine was recovered and rendered safe by Royal Navy divers—a 1,700-pound, multiple-influence, Soviet bottom mine completely unknown in the West. Later it was proven that Libyan naval personnel aboard the commercial ferry *Ghat* had rolled off the mines as the vessel meandered throughout the waterway, completely unchallenged, for more than two weeks.

On 21 April 2004 a tugboat operator on Lake Ponchartrain, Louisiana, spotted a suspicious floating bag and called the U.S. Coast Guard. The Coast Guard contacted the Jefferson Parish bomb squad, which fished the bag out of the water. It proved to be a water-borne IED—a couple of pounds of explosive in plastic pipes with a timer, wrapped in trash bags to keep it afloat just under the surface.



MISSIONS AND TASKS

U.S. Navy mine countermeasures missions are driven by the need to establish a naval and maritime “sea shield” that enables the six core capabilities of U.S. Maritime Forces articulated in the tri-service *Cooperative Strategy for 21st Century Seapower*:

- Forward Presence
- Deterrence
- Sea Control
- Power Projection
- Maritime Security
- Humanitarian Assistance and Disaster Response

Mine countermeasures capabilities are important contributors to the unfettered operations of the Navy’s warships and support vessels, as well as commercial shipping movements. Counter-mine operations can take place in U.S. and overseas ports and waterways, along the sea lines of communication, and in fleet operations areas: aircraft carrier strike group operations areas, expeditionary strike group operations areas, and littoral penetration areas. This last presents the most challenging requirements, as mine-hunting and sweeping tasks in support of ship-to-objective maneuver missions must be carried out in shallow water, surf and landing zone areas, often in very tight time-critical schedules.

Indeed, the Navy’s Sea Power 21 strategic vision, *Cooperative Strategy*, and global concept of operations anticipate increased presence of naval and maritime power in the littorals, where the most mine threats will be encountered. The Service’s Sea Shield mine countermeasures capabilities must be able to:

- Assure freedom of operations for joint forces throughout the maritime operational environment
- Project a defense around joint, allied, and coalition forces
- Provide a sea-based layer of homeland defense and security

The last is of increasing importance. The U.S. *National Strategy for Maritime Security*, *National Strategy for Homeland Security*, and *National Infrastructure Protection Plan*, among other presidential directives and plans, outline the need to protect vulnerable U.S. maritime assets. For example, The Maritime Operational Threat Response (MOTR) plan and its outline of supported and supporting relationships are particularly important for defending against mines and underwater improvised explosive devices in domestic waterways. The plan includes mines in its catalog of threats to U.S. maritime security and identifies the Department of Defense as “the lead MOTR agency for tactical response and

resolution of nation-state threats within the maritime domain,” as well as for “maritime terrorist threats that occur in the forward maritime areas of responsibility.”

Thus, the Navy’s Mine Force routinely carries out mine countermeasures operations from the high-water mark on shore to water depths greater than 200 feet. Countermeasures operations can be carried out in a crowded port, in narrow assault breaching lanes, and in fleet operating areas totaling many thousands of square nautical miles. The combination of mine countermeasures operations areas and the diversity of mine types and characteristics greatly complicate the mine-defense “problem.” Tactics and techniques that apply to one water regime or one size area and its associated mine threat do not always apply to others. No other naval warfare area presents such a diversity of environments and threats, and several critical questions must be answered to ensure effective mine countermeasures operations:

- What intelligence do we have about the weapons and minelayers?
- Where might they be deployed?
- What are the local oceanographic, bottom, and environmental characteristics?
- What is already on the bottom?
- How do we know when something new is there?
- What port or waterway infrastructure needs to be protected from mines and UWIEDs, as well as from the countermeasures operations, themselves?

With these concerns in mind, mine countermeasures operations can be broken into two major categories of tasks: mine hunting and minesweeping.

HUNT IF YOU CAN...SWEEP IF YOU MUST

Mine hunting provides a relatively high degree of certainty that an area of concern is mine-free or the risk of a mine strike has been minimized. It comprises five steps: detection, classification, localization, identification, and neutralization. Sonars are the primary means to detect and classify mine-like contacts. Identifying each contact as a mine or a “NOMBO” (Non-Mine/Mine-Like Bottom Object) can also be carried out by EOD divers and the Navy’s marine mammal systems, video cameras on mine neutralization vehicles, and laser systems. In this regard, advanced sonars on unmanned underwater vehicles offer good promise to enhance mine-hunting capabilities.

“What keeps me up at night? The threat of water-borne IEDs.”

*Admiral Thad Allen, USCG
Commandant, U.S. Coast Guard
August 2007*

A contact that is classified as mine-like must be identified as a mine or NOMBO and, if a mine, rendered safe before the Navy mine countermeasures commander, or the Coast Guard in a domestic mine crisis, can declare a route or area cleared. (As the Lead Federal Agency for maritime homeland security, the Coast Guard's Captains of the Port are the only officials who can close and open U.S. ports in response to an emergency.) Depending on the accuracy of the location of the contact, the characteristics of the bottom (e.g., smooth or rough), sediment type, amount of clutter, and the depth of the water, among other factors, the process of reacquisition and identification of each mine-like contact can take several hours. EOD divers, marine mammals, and mine-neutralization systems are the Navy's primary means for neutralizing sea mines and underwater IEDs.

The **two types of minesweeping** are mechanical and influence systems. **Mechanical sweeping** consists of cutting the tether of mines moored in the water volume or other means of physically damaging the mine, such as chain drags to cut control wires. Moored mines cut loose by mechanical sweeping must then be neutralized or rendered safe for subsequent analysis. **Influence minesweeping** consists of simulating the magnetic, electric, acoustic, seismic, or pressure signatures of a ship so that the mine fires.

IRAQI FREEDOM SUCCESS

In March 2003, even as U.S. and British land forces were sweeping Saddam Hussein from power, naval forces and humanitarian shipping were threatened by the presence of naval mines in Iraqi waters. Unlike the Navy's experiences of 1950 and 1990-1991, however, Iraqi Freedom mine countermeasures operations were an unqualified success.

The Navy's four forward-based minesweepers in the Arabian Gulf, augmented by continental U.S.-based mine countermeasures assets and EOD experts as well as Australian and British forces were key to clearing mines in the *Khor Abd Allah* waterway. The continuous presence of U.S. naval forces in the Gulf since 1991 and good intelligence prior to the outbreak of hostilities prevented Iraq from sowing many mines.

Special Operations Forces and Naval Special Warfare teams captured several disguised Iraqi minelayers with more than 100 mines—including Iraqi copies of the Italian Manta mine that seriously

damaged the Aegis guided-missile cruiser USS *Princeton* in 1991—still on board. A team of Australian, U.K. and U.S. explosive ordnance disposal personnel successfully cleared the mines that Iraqi forces did manage to put in place. This allowed vessels to deliver much-needed humanitarian aid through the port of *Umm Qasr*, and also cleared the way for strategic sealift ships to offload critical equipment and materiel for forces ashore. The EOD team then turned its attention to the *Az Bayer* port-clearance operation in April.



Intelligence, surveillance, and reconnaissance of an adversary's mining objectives and tactics are extremely important when influence sweeping, as is specific intelligence on the operation of a mine's sensors, firing criteria, and any counter-countermeasures (e.g. ship counters and delay arming). Minesweeping is more risky to the sweeping platform than mine hunting and, when completed, generally leaves behind a higher residual risk to vessels that transit the swept area. To ensure as low a risk as possible, then, most mine countermeasures operational plans include both mine hunting and minesweeping.

DEDICATED MINE COUNTERMEASURES CAPABILITIES

In mid-2009, 14 *Avenger* (MCM-1)-class ships comprise the Navy's dedicated surface mine countermeasures capabilities. Four are forward deployed to the Arabian Gulf; two are home-ported in Japan; and the remaining eight are moving from their 2009 homeport in Ingleside, Texas to the new Mine Warfare Center of Excellence in San Diego, California by 2010. Soon thereafter, two additional ships will forward deploy to Japan. The *Avenger*-class ships are fitted with several systems to carry out mine countermeasures operations:

Surface mine countermeasure forces in the Gulf comprised the four U.S. minesweepers stationed in Bahrain—the USS *Ardent* (MCM-12), *Cardinal* (MHC-60), *Dextrous* (MCM-13), and *Raven* (MHC-61)—and six Royal Navy minesweepers—HMS *Blyth* (M-111), *Bangor* (M-109), *Brocklesby* (M-33), *Grimsby* (M-108), *Ledbury* (M-30), and *Sandown* (M-101)—and their mothership, the Royal Fleet Auxiliary Landing Ship Logistic *Sir Bedivere* (L-3004). Data from the U.S. Navy MH-53E Sea Dragon airborne mine countermeasures helicopters' sidescan sonar surveys enabled coalition ships to work their way slowly up the waterway, investigating each contact, ultimately searching and clearing some 900 square miles of waterway. After U.S. Marines and Royal Marines secured the port of *Umm Qasr*, coalition EOD personnel started clearing the port from the landward side.

Navy Special Clearance Team ONE—comprising Navy SEALs, Marine Corps Force Reconnaissance divers, EOD divers, Mk 7 and Mk 8 marine mammals, and the Navy's first operational unmanned

underwater vehicle detachment—operated from the USS *Gunston Hall* (LSD-44) before relocating ashore in *Umm Qasr*. The team's REMUS unmanned underwater vehicle and sidescan sonars proved invaluable for the task at hand.

It was a most difficult environment: shallow water littered with debris, poor acoustic conditions because of a muddy bottom, near-bottom visibility at best limited and most times non-existent, and strong currents. This made diving operations and mine neutralization vehicle operations arduous and slow. However, once a mine-like object was detected by the helicopters' mine-hunting sonars and located precisely and classified by the ships' sonars, remotely operated vehicles, EOD divers or the marine mammals investigated and neutralized those contacts. Approximately 500 underwater contacts were investigated and about 90 were classified as mines or mine-like and destroyed, ensuring that critical humanitarian aid and military material were delivered in time.

- The **SQQ-32 variable-depth mine detection and classification sonar** displays search and classification information simultaneously, using separate search and classification transducers in a stable, variable-depth body deployed from the ship. The sonar can detect and classify moored, close-tethered, and “proud” bottom mines.
- The **SLQ-37 Magnetic/Acoustic Influence Minesweeping System** consists of an M Mk 5A straight-tail magnetic sweep combined with a TB 27/A Mk 4V or TB 26/A Mk 6B acoustic sweeping device to counter magnetic and acoustic influence mines.
- The **SLQ-38 Mechanical/Orepesa (cable-cutting) Sweep** is designed to cut the mooring cable of buoyant mines that are near the surface. The SLQ-38 uses a rugged wire and cable cutters, and can be rigged on either side or both sides of the minesweeper.
- The **SLQ-48(V) Mine Neutralization System (MNS)** is an unmanned submersible that can neutralize bottom and moored mines. After a target is detected by the ship’s SQQ-32 sonar, the MNS is put in the water and swims to reacquire the target, guided by the submersible’s high-definition sonar. Once the contact is reacquired, a low-light-level television helps to examine, classify, and identify the contact. If determined to be a bottom mine, the MNS can place an explosive charge next to the mine, the MNS is retrieved, and the explosive charge destroys the mine. If the target is a moored mine, the MNS can attach a charge on the cable near the mine case to “blow in place” or can cut the cable to allow the mine to rise to the surface, where it is rendered safe or destroyed.



The *Avenger* surface mine countermeasures vessels are beyond the midpoints of their service lives, and the last ship will retire in 2024. The Navy is upgrading several systems to ensure their capabilities to carry out today’s and tomorrow’s tasks. Key initiatives include:

- Modifying the SQQ-32 mine-detection sonar with a high frequency wide-band capability
- Providing a new, more capable Expendable Mine Neutralization System (EMNS) to replace the legacy SLQ-48 Mine Neutralization System
- Upgrading the mechanical and acoustic/magnetic influence sweep systems
- Providing improvements to the bow thruster, voltage regulators, frequency converters, communications suite, and navigation systems

The airborne “leg” of the Navy’s mine countermeasures “triad” comprises two squadrons of **MH-53E Sea Dragon helicopters**, a total of 28 airframes, which includes training and “pipeline” aircraft. Both squadrons are being collocated at Naval Air Station Norfolk’s Airborne Mine Countermeasures Center for Mine Warfare Excellence. The helicopters carry out rapid minesweeping tasks; they can hunt for, identify, and

neutralize mines; and they can be airlifted anywhere in the world within 72 hours of the decision to deploy. The Navy has begun a Fatigue Life Extension Program for structural upgrades to the airframes, which will ensure that the helicopters can perform their missions until they are retired. The Sea Dragons employ the following mine countermeasures systems:

- The **AQS-24 multi-beam side-looking mine-hunting sonar** detects and classifies moored, close-tethered, and bottom mines. The AQS-24 can also be fitted with a laser line-scan device that allows targets that have been classified as mine-like to be positively identified as mines or NOMBOs.
- The **A Mk 2(G) Acoustic Sweep** (also called “rattle bars”) consists of parallel pipes or bars, towed together to produce medium- to high-frequency acoustic energy that fires acoustic-influence mines.
- The **Mk 103 Mechanical Sweep** system consists of a rugged tow wire, explosive cutters, a depressor, otters, floats, and float pendants to target shallow-water moored mines.
- The **Mk 104 Acoustic Sweep** is a self-rotating cavitating disk inside a venturi tube driven by the flow of water while towed by the helicopter; it is used to counter acoustic-influence mines.
- The **Mk 105 Magnetic Sweep** is used to counter magnetic influence bottom mines. It is towed by the helicopter and consists of a gas turbine generator mounted on a sled. The generator produces power for the open-loop-electrode magnetic sweeps, which pulse electrical energy to replicate the magnetic signatures of surface ships.
- The **Mk 106 Combination Sweep** is a combination of the Mk 104 and Mk 105 sweeps and is effective against magnetic and acoustic influence mines.

The third “leg” of the “triad” is the Navy’s **Explosive Ordnance Disposal detachments** that guarantee the safety of people, ships, aircraft, installations, and operations at risk from unexploded ordnance. Highly skilled technicians render safe all types of conventional and unconventional ordnance, improvised devices, and weapons of mass destruction—chemical, biological, radiological, nuclear and enhanced-explosive weapons. They carry out operations at sea and on land—from the arctic to the tropics—and completely and seamlessly integrate with Navy, Marine Corps, Joint, inter-agency, and international commands.



EOD Mine Countermeasures personnel directly support mine-hunting and -clearance operations. They have specialized training in countermeasures-unique equipment and tactics, techniques, and procedures to locate, identify, neutralize or recover or dispose of sea mines, torpedoes, and other undersea weapons, including underwater IEDs. Key systems include advanced non-magnetic and acoustically silent diving gear, special-purpose hand-held sonars, and recovery or neutralization equipment. Shaped charges or other explosives can “blow in place” mines, while balloons provide the capability to lift 2,000-pound weapons to the surface for subsequent rendering-safe. Navy EOD mine countermeasures divers often recover mines to disassemble them and learn how they work. Depending on their assessment of a weapon’s technologies, key components, and functions, EOD techs in the field can determine what types of targets the mine’s sensors are intended to detect and what its area of coverage is for a specific ship target. Based on these data and assessments, the mine countermeasures commander can most safely and effectively allocate counter-mine resources.

The Navy also maintains several types of **Marine Mammal Systems**, specially trained bottlenose dolphins and sea lions for mine detection and neutralization, swimmer defense, and recovery of mines, torpedoes, and other objects. In some situations, the marine mammals are much more effective than humans or in-service hardware, and they are the only mine countermeasures system that can detect buried bottom mines, until the introduction of the Surface Mine Countermeasures Unmanned Undersea Vehicle. Each “system” has several dolphins or sea lions that can be deployed quickly throughout the world by strategic airlift and can also be worked from ships in forward operating areas. The in-service “systems” are:

- **Mk 4 Mod 0** dolphins detect and neutralize buoyant close-tethered mines near the bottom
- **Mk 5 Mod 1** sea lions attach recovery pendants to exercise mines, torpedoes and other test objects, as well as other items of interest in water depths greater than 500 feet.
- **Mk 6 Mod 1** dolphins that defend harbors, anchorages and individual ships against combat swimmers and divers, a capability that was first used at Cam Rahn Bay in Vietnam in 1971 and has been deployed several times since then.



- **Mk 7** dolphins detect, locate, and mark or neutralize “proud” as well as buried bottom mines in a post-assault environment for follow-on forces insertion
- **Mk 8** dolphins are designed to detect, locate, and mark or neutralize “proud” as well as buried bottom mines in a pre-assault environment to enable the initial assault to get ashore

The Navy’s mine countermeasures dolphins deployed to the Arabian Gulf in 1988 during Operation Earnest Will, in 1991-92 during Operation Desert Storm/Desert Sweep, and 2003 in support of Operation Iraqi Freedom.

ORGANIC MINE COUNTERMEASURES

The Navy’ dedicated mine countermeasures force is aging at the same time that the mine threat continues to modernize. As a result, the Navy is making significant investments for the future mine-defense force. The requirements are for a new capability that is fast, light, agile, adaptable, precise, and modular—and that ultimately will remove the man and the marine mammals from the minefield. During the next decade, the Service will transition the mine countermeasures capability from today’s dedicated assets to an **aircraft carrier and expeditionary strike group-focused organic force**. Indeed, critical organic elements are already being delivered to the fleet.

The keystone of this future force is in service, today. The **Littoral Combat Ship** (LCS) is the principal host for the **MH-60S multi-mission helicopter** and several vital mine countermeasures “mission module” systems. Focused-mission mine, anti-submarine and anti-surface warfare mission packages are being developed that will provide capabilities critical to forcible entry, littoral sea superiority, and homeland-defense missions. The ship will also possess inherent capabilities to conduct missions supporting intelligence, surveillance and reconnaissance, special operations and maritime interception, regardless of specific mission package installed.

Eight systems comprise the **LCS Mine Countermeasures mission package**, and all except the WLD-1 Remote Minehunting System (RMS), Coastal Battlefield Reconnaissance &

U.S. Navy Mine Countermeasures Priorities

- Modernize and maintain the current fleet capabilities
- Execute Organic Mine Countermeasures programs and establish performance baselines
- Align Mine Countermeasures programs with Combatant Commanders’ Integrated Priority Capabilities Lists
- Establish a responsive modernization program focused on:
 - Improving area clearance rate
 - Inserting advanced technology
 - Relying on open architecture systems
 - Expanding the mine warfare industrial base



Analysis (COBRA) system, and Surface Mine Countermeasures Unmanned Underwater Vehicle will be deployed from the MH-60S helicopter. These systems provide capabilities to detect, identify, neutralize, and influence-sweep mines. The mine warfare mission package could also be deployed for use on other ships as well as from facilities ashore. The USS *Freedom* (LCS-1) was commissioned in November 2008 and has commenced post-delivery test and trials. The first mine countermeasures mission package delivered in September 2007.

The **MH-60S helicopter** will provide mine warfare support and will partner with the MH-60R helicopter for surface warfare missions carrying the same forward-looking infrared air-to-ground sensors and weapons. The MH-60S will be reconfigurable to provide Combat Search and Rescue and Naval Special Warfare support to joint theater operations. Airborne mine countermeasures operations will be accomplished using advanced sensor and weapons packages to provide detection, localization, and neutralization of anti-access mine threats.



The **Remote Multi-Mission Vehicle (RMMV)** is an unmanned, semi-autonomous, snorkeling vehicle that tows the AQS-20A variable-depth sonar to conduct mine-hunting operations. The RMMV is capable of real-time line-of-sight and over-the-horizon operations using pre-programmed search patterns. Once the mission is completed, RMMV returns to the ship and data will be downloaded for post-mission analysis.



The **AQS-20A Mine Hunting Sonar** is an underwater mine-detection sonar housed in a towed, underwater body that can maintain operator-selected depths below the surface or heights above the bottom. It employs an electro-optic identification sensor capable of locating and identifying bottom, close-tethered and moored sea mines. The mine-hunting system will be deployed and operated from the Remote Minehunting System and the MH-60S helicopter on board the Littoral Combat Ship as part of the Mine Warfare Mission Module.



The **AES-1 Airborne Laser Mine Detection System (ALMDS)** is a high-area coverage, electro-optic airborne mine countermeasures laser system that uses Streak Tube Imaging Light Detecting and Ranging (LIDAR) to detect, classify, and localize floating and near-surface moored sea mines. Deployed from the MH-60S helicopter, ALMDS will satisfy the Navy's need for a quick-response, wide-area, organic system that can rapidly detect and classify mine-like contacts for subsequent neutralization. This capability will be critical in littoral zones, confined straits, choke points, operating areas and amphibious objective areas. ALMDS offers a much greater area search rate than other types of airborne mine countermeasures equipment, and it represents a capability that does not exist in the current inventory.



The **AQS-235 Airborne Mine Neutralization System** (AMNS) is an expendable, remotely operated mine-neutralization device that leverages and integrates non-developmental and commercial-off-the-shelf technologies. Deployed from MH-60S helicopters, the AMNS will reacquire and neutralize previously identified targets, using the Archerfish Common Mine Neutralizer against “proud” bottom and in-volume sea mines.



The **ALQ-220 Organic Airborne and Surface Influence Sweep** (OASIS) will provide the strike group with an organic, high-speed, magnetic and acoustic influence sweep capability deployed from the MH-60S helicopter to effectively neutralize sea mine threats in operating areas where mine hunting is not possible due to mine burial or high bottom clutter. Forward and aft electrodes generate the magnetic signature, which is engaged after deployment and disengaged prior to recovery and captive carriage. A water-driven acoustic generator creates the acoustic energy that mimics a ship’s signature.



The **AWS-2 Rapid Airborne Mine Clearance System** (RAMICS) is an MH-60S helicopter-deployed system capable of reacquiring and neutralizing near-surface moored and surface/floating mines in day and night operations. RAMICS fires a Mk 258 Mod 1 30mm supercavitating projectile from a Mark 44 Bushmaster II gun. The supercavitating tungsten projectile is specially designed for traveling tactical distances in air and water and through a mine casing, causing a low-order deflagration of the weapon. The gun is controlled by a fire-control system with targeting algorithms coupled with a Light Detection and Ranging system. The LIDAR locates and targets the mine and provides aiming coordinates to the gun’s fire control system to fire a burst of rounds at the mine for immediate and positive mine neutralization. RAMICS removes the man and the mammal from the minefield.



The **Coastal Battlefield Reconnaissance & Analysis System** is a multi-spectral imagery capability to conduct unmanned aerial reconnaissance in the littoral battle space to detect minefields, mine lines, and obstacles in the surf zone and beach exit areas. The COBRA Airborne Payload Subsystem is a modular architecture based on the MQ-8B Fire Scout Vertical Takeoff and Landing Unmanned Aerial Vehicle. COBRA is integral to the Navy’s Assault Breaching System, which has focused on the development of standoff weapons systems to counter mine and obstacle threats in the surf and beach zones. The program uses a “system-of-systems” approach that integrates COBRA with the Countermine System and counter-obstacle, precision craft navigation, lane marking, and command-and-control capabilities. A near-term capability using the Joint Direct-Attack Munition (JDAM) was fielded in 2007, with an enhanced far-term capability expected by 2015.

OPERATIONAL “TACSIT”

The mine countermeasures commander must consider a set of unique circumstances—e.g., mine types, number of mines planted, minefield purpose and construction, bathymetry, environmental conditions, bottom type, bottom sediment, NOMBOs—in the development of any countermeasures plan. The plan will apply mine countermeasures techniques against the threat in an integrated, logical and orderly progression of events, usually with the objective to clear an area of mines as quickly as possible and minimize the residual threat. Both dedicated and organic countermeasures systems can contribute to mission success. The near-surface threat would be addressed, first:

Dedicated Force

- Mechanically sweep with airborne mine countermeasures helicopters
- Neutralize swept mines with explosive ordnance disposal divers

Organic Force

- Hunt with the Airborne Laser Mine Detection System
- Neutralize mines with Rapid Airborne Mine Clearance System

In all of the Navy’s dedicated and organic mine countermeasures operations, however, understanding the mine warfare factors of the nation’s maritime domain awareness will be critically important for success in this complex and demanding naval warfare area.

MINE DOMAIN AWARENESS

Maritime Domain Awareness—what the *National Strategy for Maritime Security* describes as the “effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of the United States, and identifying threats as early and as distant from our shores as possible”—will be necessary for success against a broad spectrum of maritime threats, but especially mines and underwater IEDs. Without doubt, the best countermeasures will keep the weapons from being deployed in the first place. But, if that tactic fails and weapons are in the water, the Navy—and increasingly the U.S. Coast Guard under the National Fleet Policy in support of domestic mine countermeasures needs—must have detailed knowledge of the threat and the physical environment, in short, **Mine Domain Awareness**.



“**Know your enemy**” has been a fundamental military precept for millennia. That said, about 90 percent of all mine hunting and sweeping operations have been conducted in areas in which mines have *not* been deployed—underscoring the need for good actionable intelligence. Indeed, strategic, operational, and tactical in-

telligence about the threat is absolutely essential, a fact-of-life confirmed in the 1991 and 2003 Arabian Gulf operations. Today, numerous U.S. government agencies, and those of key allies, as well, contribute to U.S. mine warfare capabilities.

At the **strategic level**, the intelligence community and the Departments of State, Commerce, and Defense monitor the mine warfare activities of potential adversaries. Additionally, these departments work with allies and industry to develop a clear picture of commercial mine-marketing efforts.

At the **operational level**, the Departments of Defense and Navy monitor the development, acquisition, and sale of sea mines through intelligence-collection activities and interaction with foreign militaries. Potential adversaries' mine "orders of battle" are tracked and assessed: What kinds of mines are in their stockpiles? How do the mines fire? What is the explosive weight of the mines? Where are the mines stockpiled? How are the mines transported to assembly points or staging sites? What routes and types of vehicles are used? What kinds of assets or vessels are used for mine laying? What is the location of the mine-laying assets? To support this analysis, foreign mines can be acquired for technical analysis and to develop tactics, techniques, procedures, and equipment to counter them.

Finally, at the **tactical level**, the Navy and other agencies monitor training and exercises to answer key questions about adversaries' mine warfare capabilities: What is the offensive or defensive mining strategy—blockade, area denial, harassment? What mine types are available to support the strategy? In a crisis or conflict, have mines been laid and how many are in the water? Where are they laid? What minefield patterns are used? Is reseeded part of the strategy? How will reseeded occur? All these and more contribute to the Navy's mine countermeasures posture.

"The United States must be prepared for any potential terrorist activity in our ports, harbors and waterways, including threats from maritime mines and Underwater Improvised Explosive Devices."

*Admiral Patrick M. Walsh, USN
Vice Chief of Naval Operations
January 2008*

OPERATIONAL "TACSIT" (CONTINUED)

Once the near-surface mine threat has been addressed, the mine countermeasures commander would clear in-volume, close-tethered, and bottom mines:

Dedicated Force

- Hunt with SQQ-32 sonar on surface mine countermeasures ships
- Hunt with AQS-20A sonar on airborne mine countermeasures helicopters
- Identify and neutralize with EOD divers, Mine Neutralization System or Expendable Mine Neutralization System
- Identify with Laser Line Scan system
- Influence sweep with airborne and surface mine countermeasures systems

Organic Force

- Hunt with Remote Minehunting System or MH-60S helicopter with AQS-20A sonar
- Reacquire and identify with Remote Minehunting System or MH-60S/AQS-20A configured with Electro-Optical Identification System
- Neutralize with Airborne Mine Neutralization System
- Influence sweep with Organic Airborne and Surface Influence Sweep system

Likewise, to prepare for a possible domestic mine crisis, accurate intelligence about the terrorist mine and underwater IED threat is absolutely essential: What terrorist groups are active? What weapons might they have? Are there any indications and warning that they are planning single or multiple strikes in U.S. waters? What tactics might they employ? In addition to good strategic and operational intelligence, existing and future vessel surveillance, identification, and tracking systems and organizations, such as the Coast Guard/Navy Joint Harbor Operations Centers, need to be focused at the tactical level to the potential need to detect, control, and engage minelayers before they start their tasks.

The second critical factor contributing to U.S. mine domain awareness is good knowledge of the physical, geographic, oceanographic, bathymetric, and environmental characteristics of potential mining areas and data of sufficient quality and currency to support mine countermeasures operations. These factors will drive both the use and placement of mines and the tactics and the choice of techniques used to counter them. The “**intelligence preparation of the environment**” is critical for operational success, whether the need is halfway around the world or in U.S. coastal waterways, ports, and rivers.

Exacerbating the **domestic mine and underwater IED challenge** is the fact that no two ports are alike: compare New York/New Jersey, Baltimore, Norfolk, Jacksonville, Houston, San Diego, San Francisco, Seattle, and Hawaii—among a total of some 360 U.S. ports. Each differs in geography, channel layout, bathymetry, wind, tide, current, bottom sediment, turbidity, climate, and critical infrastructure—piers and wharves, moorings, navigation markers, cables, pipelines, and more, with most bottom infrastructure uncharted or its location long forgotten—making the already complex problem of detecting, identifying and defeating mines and underwater IEDs in U.S. ports even more daunting. For these reasons, the Navy has embarked on a program of focused bottom surveys of key ports and waterways to facilitate change-detection and mine countermeasures operations in an emergency.



Indeed, Mine Warfare Environmental Surveys, Mine Warfare Pilots, and bottom surveys provide the information and knowledge that are critical to the conduct of mine countermeasures operations at home and overseas. The Navy’s Mine Warfare and Environmental Decision Aids Library (MEDAL) is the Service’s Mine Warfare Decision Support System, enabling and supporting forces with a single command and control tool. MEDAL provides tactical decision aid functionality to the warfighter, including integrated mission planning, evaluation, and

situational awareness capability. MEDAL also provides the warfare commander and other supporting commanders with coordinated mine warfare situational awareness. MEDAL integrates intelligence preparation of the environment data, mission planning and evaluation, situation awareness, and command-and-control capabilities to support the Mine Countermeasures Commander, organic and dedicated mine countermeasures operators, and all naval and maritime forces requiring mine warfare situational awareness.

Likewise, environmental and oceanographic knowledge is important for the Navy's mining strategies and operations, and must be taken into account by minefield planners to ensure that U.S. mines are effective against intended targets.

MINES AND MINING

The aircraft-deployed Quickstrike mines are the only mines in the Navy's inventory in 2009. They include one dedicated thin-wall mine, the Mk 65, 2,300-pound mine, and two mines converted from bombs, the Mk 62 500-pound and Mk 63 1,000-pound mines. Because the Mk 62/63 mines are bomb-conversion weapons, aircraft carrier air wings have the flexibility to conduct mining operations without the need to carry mines as additional ordnance.

Countering an enemy surface ship or submarine threat in the littorals is a mission well suited to Quickstrike. Tactically, a well-placed Quickstrike minefield could facilitate finding and neutralizing enemy ships and submarines by trapping them in port at the beginning of a conflict, or making sure they could not make it to homeports safely. They could also have strategic impact, as Operation Starvation underscored in 1945.

Quickstrike mines are being upgraded with the Target Detection Device (TDD) Mk 71, a state-of-the-art firing mechanism. It can sense magnetic, seismic, and pressure

“Deployed surreptitiously underwater or delivered by suicide boats, IEDs in our ports and waterways could have chilling effects on the nation’s trade—more than 90 percent of which is carried by ship and is critical for our globalized just-in-time and just-enough economy. Response to a domestic IED threat will be completely different from what U.S. forces handle overseas, as there are law-enforcement and infrastructure-protection concerns here that do not figure in military operations.”

*The Honorable Jay M. Cohen
Under Secretary for Science and Technology
Department of Homeland Security
March 2008*



signatures and can be programmed with sophisticated target-processing algorithms and counter-countermeasures. This enables the Navy's miners to optimize performance against different target classes and to counter future threat targets. Engineering development efforts include advanced algorithms for ship detection, classification and localization against likely threats, including quiet diesel-electric submarines, mini-sub, fast patrol boats and air-cushioned vehicles.

The Naval Mine and Anti-Submarine Warfare Command has the authority for planning all U.S. Navy mining operations, including requirements analysis, preparing mining plans, and operations. The Commander, Mobile Mine Assembly Group, a subordinate command of the Naval Munitions Command, has the responsibility for mine stockpile maintenance and requirements. Mobile Mine Assembly Group has six Mobile Mine Assembly Units located around the world that maintain a mine inventory suitable for their areas of responsibility. Should the need arise, the mine assembly units prepare mines for pre-planned minefields and deliver those mines to component commanders for deployment.

ORGANIZING FOR MINE WARFARE

Immediately after Desert Storm, the Navy addressed the mine warfare challenges and lessons learned from the crisis. The Navy established the Commander Mine Warfare Command as the single Flag Officer responsible for mine warfare. Additionally, the Navy put in place an Expeditionary Warfare Directorate (N85) on the staff of the Chief of Naval Operations (OPNAV) to oversee mine warfare requirements and funding issues. The Navy also established the Program Executive Office for Mine Warfare (PEO MIW) to oversee all mine-warfare related research and development and acquisition programs—a strategic linkage between the Assistant Secretary of the Navy for Research, Development and Acquisition and the Naval Sea Systems Command. And, it put the processes in place to ensure that the requirements, programs, and operational perspectives remained in sharp focus.

While the names of these key organizations have changed, the Navy has continued to strengthen the mine warfare framework it put in place nearly two decades ago. The Naval Mine and Anti-Submarine Warfare Command (NMAWC) is responsible for mine warfare operational planning in response to regional Combatant Commanders' tasking. The Director Expeditionary Warfare remains the OPNAV mine warfare resource sponsor, while oversight for all mine warfare—as well as many other littoral warfare programs—research and development, and acquisition are today the focus of the Program Executive Office for Littoral and Mine Warfare (PEO LMW).

The Chief of Naval Operations has also instituted a fleet collaborative team process to drive the Navy's mine warfare programs and operations. With oversight from U.S. Fleet Forces Command and Commander Pacific Fleet, the Commander Third Fleet is the operational agent

responsible for the Navy's Mine Warfare mission area. The Commander Naval Mine and Anti-submarine Warfare Command is the Flag Officer and principal naval authority for the mine warfare mission—co-equal with anti-submarine warfare—and head of the anti-submarine and mine warfare fleet collaborative team. Specifically focusing on mines and mine countermeasures, the Naval Mine and Anti-Submarine Warfare Command is charged to:

- Develop mine warfare doctrine, tactics, techniques, and procedures
- Focus across the mine warfare mission area to include resource sponsors in the Office of the Chief of Naval Operations, the Navy's Systems Commands, government and private laboratories, and experimentation initiatives
- Articulate mine warfare operational and future readiness capabilities requirements
- Promote rapid delivery of new technologies and training, through the Sea 21 Sea Shield and Sea Trial “pillars”
- Promote mine warfare training and qualification improvement
- Support mine warfare performance assessment
- Support operational commanders with a standing deployable mine warfare battle staff that can carry out several vital functions, including mine warfare operational and contingency plan development, maritime component commander and theater staff support, and delegated operational control of air, surface, and underwater mine countermeasures forces

The Navy's mine warfare mission area, particularly the mine countermeasures force, is thus in transition from a legacy force of dedicated mine countermeasures platforms to a more mobile, more responsive, and more available countermeasures capability that will provide fleet operators with shorter timelines, more certain clearance, and reduced risk, while ultimately removing the man and the mammals from the minefield.

U.S. NAVY MINE WARFARE VISION

The Navy has articulated an overarching vision for 21st-Century Mine Warfare. The principal objective of the Navy's Mine Countermeasures Vision is to decrease significantly the time required to conduct countermeasures operations, while ensuring low risk to naval and commercial vessels, and to remove the man from the minefield. Additionally, the Service will continue to address the nation's mining capabilities to support national strategies and operational plans.

To accomplish this Mine Countermeasures Vision, the Navy is already embarked in the design of an enhanced capability based on a common set of unmanned, modular systems that can be organic to aircraft carrier and expeditionary strike group operations. This modular capability

“Successful mining of the sea lines of communication is a show stopper. Today's global system of commerce assumes that they will always be open.”

*Admiral Gary Roughead, USN
Chief of Naval Operations
April 2009*

will also be able to be used on other ship platforms of opportunity or from bases ashore. The Mine Countermeasures Vision also includes the ability for the Mine Countermeasures Force and its systems to be distributed over large areas and networked through a system of off-board nodes. Supporting surveillance systems, both for intelligence and the environment, will also be integrated into this network. Key enablers of the Navy's Mine Countermeasures Vision are the overarching concept of operations; the development of cooperative, unmanned, modular systems; the establishment of a capable networked command and control system; and standing up an accurate and interactive environmental system with the ability to form and disseminate a Common Environmental Picture.

The Navy will continue to close capability gaps, especially those that might frustrate achieving primary mine countermeasures goals. The Navy will work to transition Science and Technology systems into the fleet, to identify additional capability gaps and to provide direction to the Science and Technology community. Critical technologies and capabilities needed to ensure that the Navy's Mine Countermeasures Vision is achieved include:

- Improve detection capability
- Decrease sensor false alarm rate
- Reduce or eliminate post-mission analysis detect, classify, identify, decide time
- Improve neutralization time
- Improve network communications
- Automatic target recognition
- Achieve in-stride detect-to-engage capability

The Mine Countermeasures Force that results from this Vision will include a common set of distributed, cooperative, unmanned, modular systems netted into a common command-and-control architecture, which are able to be operated from a variety of platforms and can counter all mine threats throughout all environmental and operational situations.

The Navy will also continue to improve its mining capability centered on the Quickstrike family of mines. Advanced targeting algorithms and counter-countermeasures will be pursued for the Target Detection Device Mk 71, and sufficient quantities of this advanced mine sensor will be acquired to meet projected operational requirements.

Mine warfare—the ability to counter an adversary's mines as well as to use mines to support national strategies and operations—is a vital national capability. The Navy's Mine Warfare Vision is focused and clear, and the Service has put in place forward-leaning research and development, acquisition and in-service programs that will increase critical capacity. Most fundamentally, however, the highly skilled and experienced people who carry out complex and dangerous mine warfare tasks are the foundation for success in this most challenging naval warfare area. ***As E. Anne Sandel, Program Executive Officer for Littoral and Mine Warfare, upon Assumption of Command, stated: "We are going to deliver the best possible Mine Warfare capability to our Sailors and Marines. That is our mission and our single most important objective."***

MINE WARFARE READING LIST

Belknap, Reginald R., Capt. USN. “The North Sea Mine Barrage,” *National Geographic Magazine*, February 1919

Duncan, Robert C. *America's Use of Sea Mines* (White Oak / Silver Spring, MD: Naval Ordnance Laboratory, 1962)

Greer, William and James C. Bartholomew. *Psychological Aspects of Mine Warfare* (Alexandria, VA: Center for Naval Analyses, 1982)

Griffiths, Maurice. *The Hidden Menace* (Greenwich, UK: Conway Maritime Press, 1981)

Hartmann, Gregory K., with Scott C. Truver. *Weapons that Wait: Mine Warfare in the U.S. Navy*. Updated Edition. (Annapolis, MD: Naval Institute Press, 1991)

Levie, Howard S. *Mine Warfare at Sea* (Boston, MA: M. Nijhoff, 1992)

Lott, Arnold S. *Most Dangerous Sea: A History of Mine Warfare and an Account of U.S. Navy Mine Warfare Operations in World War II and Korea* (Annapolis, MD: Naval Institute Press, 1959)

Lyons, H. Dwight, Jr., with Eleanor A. Baker, Sabrina R. Edlow, and David A. Perin. *The Mine Threat: Show Stoppers or Speed Bumps?* (Alexandria, VA: Center for Naval Analyses, July 1993)

Marlatt, Greta E. *Sea Mines and Countermeasures, A Bibliography* (Monterey, CA: Dudley Knox Library, Naval Postgraduate School, at <http://www.nps.edu/Library/Research/Bibliographies/index.html> and <http://www.nps.edu/Library/Research/Bibliographies/Sea-Mines/seamines2007.pdf.pdf>)

Marolda, Edward J., ed. *Operation End Sweep: A History of Minesweeping Operations in North Vietnam* (Washington, D.C.: Naval Historical Center, Department of the Navy, 1993)

Melia, Tamara Moser. *Damn the Torpedoes: A Short History of U.S. Naval Mine Countermeasures, 1777-1991*. Contributions to Naval History Number 4 (Washington, D.C.: Naval Historical Center, Department of the Navy, 1991)

Mine Warfare Plan: Meeting the Challenges of an Uncertain World. (Washington, DC: Office of the Chief of Naval Operations, 29 January 1992)

Morison, Samuel L. *International Guide to Naval Mine Warfare*. 2nd ed. (Washington, DC: King Communications Group, Inc., 2000)

Naval Mine Warfare: Operational and Technical Challenges for Naval Forces (Washington, DC: Naval Studies Board, National Research Council, National Academy Press, 2001)

Oceanography and Mine Warfare (Washington, D.C: Ocean Studies Board, National Research Council, National Academy Press, 2000)



PROGRAM EXECUTIVE OFFICE
LITTORAL AND MINE WARFARE
EXPEDITIONARY WARFARE DIRECTORATE

U.S. Navy
2009